Ask a Biologist vol 020 Topic: Fire and Life Guest: Stephen Pyne

Fire and Life -

Could fire be an important thing for life on Earth? Would Earth be the same without fire? These are just a few of the many questions we have for fire researcher Stephen Pyne about fire and its role with life. Did we also mention his battle with a dragon? If you have a burning desire to learn the answers to these questions, read on.

Transcript

Dr. Biology: This is Ask-a-Biologist, a program about the living world and I am Dr. Biology. What do you think about when I say these words: breathing, growing, moving? I usually think about things that are, well, living.

In today's show, we'll be talking about something just a little different. We're going to be talking about fire and even though we often use those exact same words to describe fire, well, fire is not alive. However, fire has a very large impact on all living things on Earth. Just how large an impact it has on living things including you and me, is something our guest scientist can talk about.

Stephen Pyne is Professor in the School of Life Sciences at Arizona State University. He's been researching and writing about fire for more than 30 years. In fact, you might call him a modern day knight because he's actually battled a dragon, fire and all. We get to hear more about the dragon later in the show, as well as learn about fire and its important role for life on Earth. Right now, let's greet our guest. Welcome, Professor Pyne.

Professor Pyne: Well, thank you. Delighted to be here.

Dr. Biology: OK. Let's jump into the very first question. We all know what fire is. We've seen it. We've felt it but what is fire?

Professor Pyne: Well, that is a great question. The thing is, fire is not a substance. It's not a thing in the same way. If you think of the old elements: earth, air, water and fire, all the others are things. You can put them in your hand. You can put them in a bucket, you can move them around but you can't move fire. Fire is a reaction. Fire is taking the things that make up fire and having them interact in interesting ways.

Dr. Biology: So, what do we need to make fire?

Professor Pyne: Well, you need basically three things. You need oxygen, you need fuel, that is something to burn, and then you need something to start the reaction, so you need heat or some kind of spark, or something, something to get it going - a good bolt of lightning, a good spark from flint and steel. You need something to get it going. You need a charge.

And the reaction has to produce enough heat to keep the reaction going. So, there's in a sense, in which it's a chain. So it doesn't happen just once, it's continually reigniting, it's restarting. So if you want to stop it, you take out any of those and you can bring it to a halt.

Dr. Biology: How long have humans been using fire?

Professor Pyne: Humans have been using fire for all of our existence. Early hominids, Homo erectus, say a million and a half years ago, were apparently keeping hearths, that is, they were keeping camp fires, they were keeping cooking sites in caves, in sheltered areas. They could maintain fire. It's believed that they could. This is a very long time.

Homo sapiens, probably, was able to make fire pretty much at will. So all the things we think about: "How do you get fire?" Well, you're striking it, you're drilling it, you're rubbing it, you're doing things, all of these are tools that we associate with say Homo sapiens, anatomically modern people last 100 - 130,000 years, something like that. So we've been able to make fire for that long. Other than that, I think we had to hold it.

I think that there's a very long tradition of eternal flames, of maintaining fire because it's easier to keep it going than to have to keep starting it all the time. We don't think about that. We've got matches, we've got cigarette lighters. We've got stuff to start fire all over the place. It's a wonder the whole city isn't burned to a crisp.

Dr. Biology: [laughing]

Professor Pyne: Every day, when you add up all the stuff and all the things that are freely available. I mean, we wouldn't have make weapons available this way, we wouldn't make explosives, but anybody can pick up fire starting materials for nothing. No ID, no check. Anybody can get it and do it and so we have enormous social control and self-control to keep from burning ourselves out of existence.

Dr. Biology: Well, that's interesting because we think about how fire can be destructive but fire has also a really beneficial side. So, what I'd like to talk about is the good and the bad sides of fire. So let's first, let's pick the good sides.

Professor Pyne: Sure.

Dr. Biology: What are the key elements for fire around the Earth that are so important for us and I should say all living things? Why is fire so important?

Professor Pyne: Well, there are a lot of answers to that. Fire has been around for over 400,000,000 years. It's a longstanding presence on Earth but it's been kind of lumpy. In some places and sometimes there's a lot, in some places and other times there isn't much. It has to be wet enough to grow stuff, so you've got things to burn. Then it has to be dry enough to prepare them to burn and only a few places go through those cycles.

Then you have to have an ignition, you have to have something to get it going, so lightning, maybe a volcano locally or something like that. So you're not going to have fire

everywhere. But fire has been around a long time and plants ecosystems accommodate themselves to that. And it's not a case of whether you have fire or don't have fire. That's like saying you have water or you don't have water. It's the pattern of rainfall, it's the pattern of water.

So, in the same way, it's the pattern of fire. Does it come every year? Does it come every century? How does it come? What that pattern is, is what really matters. OK, so things are adjusted to some pattern. If you change the pattern, then they're no longer adjusted. They expect that fire. They're no longer adapted to the system because something that was basic to that system isn't happening. If you change that pattern, then they're no longer adjusted. They are out of sync, they're unhappy.

In the same way that if you took a tree that was used to having rainfall every month and you put it into a climate where it only rains three months of the year, that tree is not going to be happy. So in the same way, if you take organisms that are used to having fire come very frequently and just surface flashings of fire, like a spring sweeping, a clean out, and suddenly you put it into a system where fire comes every 30 years, or every 50 years, or every 100 years and it incinerates everything, those plants are not going to be happy.

Dr. Biology: I see. Well, this actually brings us back to what we hear just about every summer, when we're watching the news, especially with a lot of the drought that's been going on, we worry about forest fires, around the country. Are we seeing more of them, or are we seeing less of them? And is this a good thing or a bad thing?

Professor Pyne: Yes to all of that. What else can we say? The pattern of fire is changing. One reason it's changing is because what we've done with fire for well over a century. We introduced heavy grazing, that took away the grasses - the grasses were what burnt. And the trees were sort of in the way of this but they weren't, basically, combusting in many cases.

We took away a source of ignition - many of the native burners who were there. And then we create public lands and we remove people and their presence, for the most part, and we begin firefighting.

So, all of this together has had an enormous impact of removing fire, and the systems are unhappy. Some systems need light frequent fires; some systems need a fire every 80 to 100 years. It just takes everything out and new growth comes up and that's how it's happy.

We've interrupted all of these and you know for 30 or 40 years now the Federal agencies have been trying to put fire back in, in the right way. And it turns out to be very hard.

Dr. Biology: Once again Mother Nature is a little bit better prepared at doing this management then we are. I have to say I see that a lot.

OK, well there really is not a bad side as opposed to fire it is more or less what we have done maybe?

Professor Pyne: We are the ones who decide if it is good or bad. Nature is not making that decision, so it is our call. We think of fire as bad when it is destroying things that were there that we value. And it may be destroying it because we've changed the pattern of fire. It is a different kind of fire. It may be destroying those because there is no fire at all. So, they are being replaced by other things that don't like fire.

Both ways; putting it in inappropriately and taking it out inappropriately, we can do things, we can damage the world out there.

Why don't we see it today? It's because - to use a big word - we've industrialized. And we are not burning surface stuff anymore - living biomass - we are burning fossil biomass. We are digging it out of the past, out of the geologic past. We are burning it in special chambers; we are converting it to electricity we are doing other things. We are seeing fire indirectly, so we don't see it ourselves as it used to be.

And when we do see it, it is almost always damaging; schools burning, houses, whatever.

Dr. Biology: But on the plus side, the electricity -- the lights that we see in the room here right now, are basically, the beginning of that is fire, right?

Professor Pyne: Most of that is. I mean there are some hydro-power dams running it, there is a little bit of nuclear. But for the most part we are still a fire creature, we're just getting our fire power differently.

Dr. Biology: There are some discussions, and they have been going on for quite awhile about the slash-and-burn that goes on down in the Amazon forest. Basically; to clear the area, to do grazing, and/or for farming. What is the effect of that on the world Ecosystem?

Professor Pyne: Well, there is a local effect and a global effect. And like most things it is good and bad news. Interesting studies have been done on slash-and-burn cultivation in Amazonia, which actually suggests it improves the biodiversity.

But we are talking about relatively small plots -- say under a hector in size-- that are slashed and burned. That keeps everything simmering at sort of a low heat that creates niches, creates opportunities, varieties of things come in.

The problem is when you expand that over something the size of Texas and you take out huge chunks and then incinerate it, well you have changed it in very unhealthy ways and perhaps permanent ways. That is very damaging and that can reduce the biodiversity. It also releases a lot of carbon.

Well, we are releasing a whole lot of carbon by driving our cars, running our power plants, and everything else. But we are also removing it by deforesting, by clearing land, and so forth. And at that point what happens in the Amazon is affecting all of us. But you know that is also true when we are driving our cars around Phoenix we are affecting the atmosphere of Brazil.

And so, we may criticize them for clearing their forest and perhaps appropriately so because of its effect on us. But they will say "Well you are promoting going out now in your National Forests and clearing off large chunks of land and burning it. And you are saying that this is ecologically good. You are putting fire back in. What is the difference?" Well, as far as the atmosphere is concerned there is no difference.

Dr. Biology: I see.

Professor Pyne: It is a tough one to answer.

Dr. Biology: I agree, the issue of global warming truly is a global topic and is going to need a global answer.

You have been working with fire for a really long time haven't you?

Professor Pyne: Well I started 40 years ago actually, when I just got out of high school. Just graduated a few days, had a job as a laborer at Grand Canyon National Park.

Showed up and it turns out that they had a cancellation on the North Rim Fire Crew and wanted to fill it. I was there signing papers so they turned and asked me "Do you want to go?" I said, "Sure." I had no idea what I was doing, what that meant, and went over to the North Rim then returned for 15 summers.

Dr. Biology: So you are a firefighter for 15 summers. I have to think there have to be some stories in there?

Professor Pyne: Well, there are a lot of stories but usually when people think of that now what they know is what they see on television. And what they see are the most dramatic; soaring flames, crown fire, end-of-the-world burning, get out of here. And that is a very small fraction of fires.

Mostly what we did is called smoke-chasing. And that's basically a plane would fly - or sometimes a lookout tower, from a lookout - after a lightning storm and would see fires while they were one tree burning. And the idea was to get there as fast as you could while it was still one or two trees and a little ground fire and tackle it. So the real challenge was finding it.

We don't have a lot of roads here, it is very hard to see, and sometimes we would often be going in late afternoon thunderstorms. We'd see it at sunset - off we would go in the middle of the night trying to find this thing. Tramping around the woods, in the dark, wondering where we were. Tying little pieces of plastic flagging tape to trees as you go along so you can find your way back out.

Dr. Biology: Ah, the trail of bread crumbs.

Professor Pyne: Exactly, except that the animals can't eat this. So you can find your way back out at night if you get lost or someone else has to come in. Then we would find the

tree; cut it down, put out the fire, do any ground fire. Usually spend the night maybe part of the next day or whatever it took, and then come back.

And so that is the strategy; to get it while it is small. Then two people would be enough. But sometimes you have half a dozen fires. So, you can't get to all of them and some of them take off.

People don't appreciate - because they see it on television, I think - how loud fires can be. And a large fire, it is like standing behind a jet engine. I mean, it is very loud and disorienting. So you are not in front of a fire like that you are working the sides to pinch it off.

Yeah, it is great, very exciting. It's fun. It's exhausting. I mean it's a kind of team sport. In a way, an extreme sport perhaps. Occasionally we would get a larger one that would flare up. The real problem fires for us were fires that started on the rim but then spilled over into the canyon.

Dr. Biology: Steep faces, is that the problem with that?

Professor Pyne: You're dealing with cliffs, with all this sort of rocky slopes. Most people see the canyon from the south rim. It's very abrupt. The north rim has more broken areas. There could be some vegetation. Extremely steep. Or mixtures of cliffs, then this steep stuff. If it goes over there, then you can't go in after it.

I remember one fire that was especially fun. It was on a place called "The Dragon." What a greatly named place!

Dr. Biology: The Dragon? Really?

Professor Pyne: It's this plateau out in the canyon. It's sort of shaped like a dragon's body. Then the ridge drops down and comes up into the head. It's a wonderful place. Lots of fires. We were out there. It went over the rim on us and we were fine. Then around midnight it had burned down, downslope and dried out all of the vegetation above. All the shrubs and small trees and stuff.

Then at the bottom it found a logger. Got cooking and then came back through the canopy. It came roaring out of the canyon. Here it is, midnight. You're at the rim of the Grand Canyon. Suddenly you've got these enormous flames boiling up out of it, coming right to the rim, right where you are. That was a fun evening.

It was a good experience.

Dr. Biology: Sounds like quite an amazing story, actually. A little scary, even, the thought. Let's put us in a hypothetical forest. We'll have a lightning strike. We'll have that big fire burn. This is before any suppressant, or any humans are going around trying to control it. You weren't there to go grab that burning tree. Can you give me a little bit of a time line of what happens as it goes through, you know, fairly quickly in the sense of from the beginning it burns to the time that things start to come back.

Professor Pyne: What fire has done in passing through this is break down all the stuff that was there. It's going to decompose it. It's going to decompose it physically, just as organisms would decompose it. It's going to do it very quickly and suddenly, so it's going to liberate lots of chemicals. Lots of nutrients are out that otherwise are not available.

Just locked up. They're stuck away in socks and buried in the ground. You need to have that circulating. You need to have that stuff. So fire is cycling all this stuff up. It's also breaking down the old physical structure of the forest. Letting light in. Making rains available. Changing the texture of the soil.

Now, how often does this have to happen for the forest to thrive? Well, it depends on the character of the forest. So one kind of forest, say a Ponderosa pine forest, that traditionally would have lots of grasses and flowers underneath it, that will happen quite often. Another kind of forest, say a Lodgepole pine or Jack pine forest, might not happen for 80 or 100 years, that would break down.

It's all going to be different. Whatever that arrangement is, it all comes into a kind of balance. So the kinds of fire you need is exactly what all these organisms are adjusted to. They create an environment where that kind of fire is possible.

Dr. Biology: It acts as a decomposer which, we know, a lot of microbes, that's exactly what they do. They act as the decomposers, which is a really important part of this whole cycle of life. Can you imagine the Earth evolving the way it did without fire?

Professor Pyne: No, because fire is a creation of life. Life made fire possible. When that kind of oxidation of hydrocarbons occurs in cells, we call it respiration. When it occurs out in the wide world, we call it fire. It's that fundamental. It's the flip side to photosynthesis. It's taking it apart. Once you have life, and life begins creating oxygen in the atmosphere, and it begins creating hydrocarbons on land, there's no way fire couldn't have occurred.

Dr. Biology: It's actually a question that's come in to "Ask a Biologist" is, why is fire not alive? Because we do talk about it breathing.

Professor Pyne: Well, we don't know how to characterize fire, in many ways. In some ways, fire is very odd because it is a creation. It is constructed. It is biologically constructed. So in a way, in that respect, it is a para-living entity. We think of fire as a quote "disturbance," ecologists will talk about it.

Fire is not like floods, or windstorms, or ice. All those can occur without a particle of life being present. But fire only occurs where you have living stuff.

Dr. Biology: Needs the fuel.

Professor Pyne: That is what provides it. Life also created the oxygen. So, it's different than the rest. That border, it is not living, but it is a creation of the living world, so it has some of the properties of the living world. It takes it with it. On the other hand, we don't

know, you're asking what is fire? We don't know where to put it, intellectually. It's very difficult.

Now, we sort of put it in chemistry, but in many ways it should be in biology. It would be better. It's not clear. We think of the other elements: earth, air, water, they all have academic disciplines. They have departments. The only fire department at ASU is the one that sends engine when you pull an alarm. We don't know where fire goes. We don't know where to put it, intellectually.

Dr. Biology: You made a transition from fire fighter to researcher and historian, and basically an expert on fire before most people ever did that sort of thing. What's it been like in the writing venue? I pulled up your profile and you have, I couldn't remember how many books it's been, but it's an awful lot now.

Professor Pyne: My 20th will be published in October. It's a study of Canada. A history of Canada told through fires.

Dr. Biology: What got you started writing?

Professor Pyne: Well, all the time I was doing this in the summer I was really living two lives. When I was at the north rim, that's all I lived. I was basically a smoke chaser, a fire guy, and we had our crew, and had a great time. Then I would go back to school and didn't study fire, didn't do anything with fire. They were two completely distinct entities. And then after I got my PhD, I'd studied history of science. I didn't have any jobs.

Wasn't sure what I would do next. Spent the winter on the south rim, thinking about things. It finally occurred to me, you know, I really like fire. It's a great subject. Why don't I take all this training I've been given as a scholar and apply that to the study of fire.

Dr. Biology: Do you like writing?

Professor Pyne: Yes, I do enjoy writing. Most people will say they like to have written, rather to write the writing itself. It's hard. I find it interesting. It's like a puzzle. It's like doing any other intellectual challenge. The secret is finding a way to express yourself. It's no good to have data. It's no good to have ideas if you can't communicate them.

Finding the way to do that, finding the expression is really fundamental to making it work. I find that fun.

Dr. Biology: Do you have a particular time of day, or a particular rhythm for your writing?

Professor Pyne: Whenever I can get it. The secret is really to find the time. That's really the secret in writing. It takes time. You have to create time for it. That means you deny yourself doing other things. And, it takes big blocks of time, generally.

Dr. Biology: Do you like words?

Professor Pyne: Yes, I enjoy words. I enjoy word play. Fire is a great subject for word play, and things. It's also a way of integrating fire, the science of fire into the culture. Showing how deeply our sense of the world is filled with fire images. Even though it's away from our daily lives now, in an urban industrial society, it's still so much a part of our heritage, and our culture.

Dr. Biology: This leads me into some of the questions I ask all of my scientists and researchers. You talk about your role as a fire fighter and then we've transitioned into your research. I usually ask, when did you first know you wanted to be a scientist, and/or writer? Basically, where did that happen? Where in the time line did you realize that's what you wanted to be?

Professor Pyne: I'm not sure there was a moment, what you might call an epiphany, where suddenly it dawned on me. I was always interested in learning. Always somehow wanted to be in a place where I could continue to study, and to learn. I grew up reading books and things and I thought, wouldn't it be wonderful to write some, to do that myself.

So, it was a slow, kind of dawning, and in a sense, a persistence. It wasn't easy. I had a hard time getting into graduate school. I'm not sure why. I had a hard time getting an academic job afterwards. Just difficult times. But, a certain amount of tenacity, and determination to stay with it. I thought this is what I should be doing.

Dr. Biology: I think perseverance is a really good quality. It sounds like that's one of the things that pulled you through on this career. Alright, well, you've had all this perseverance, and you've gotten to this point, and now I'm going to take it all away. I'm not going to let you do any writing, no research in that area. If I take that all away, what would you be?

Professor Pyne: I would have been a firefighter. I would have stayed with that. In fact, I did apply for jobs. There were none, at the time. It's an interesting path, that had there been jobs available in fire, I probably would have gone with that, because there was nothing in academics. There were neither at the time I came out.

That would have been interesting. I think I would have continued to write, and to study it, but I would have been furloughed in the winter, instead of having the summers available. It would have been the other option. Actually, that's not a bad deal, because the legislation passed gave early retirement to firefighters. Federal firefighters. I could have been retired after 20 years.

I would be on a different career by now!

Dr. Biology: What if there is another person like you out there that would like to either get into writing, or into history of science? Do you have any advice for them?

Professor Pyne: Well, the advice I give my students, now, what I think I've learned, I hope it's helpful. I've coined it into a little epigram, if you will. It's "Follow your heart, but use your head." I think that ultimately you've got to do something that you like. You

have to get excited about it. You have to really think, this is neat, this is worth spending your time, your life, doing. But that's not enough.

You have to use your head. You have to be trained. You have to be educated. You have to be sensible. How can I do this with the opportunities that are available? How do you make it happen? But simply to do things because it's good paying, or it's available, and you don't really care about it. You're really going to be unhappy. You're spending an awful lot of time doing something you don't care about.

Dr. Biology: That's good advice. One more question. It comes from driving down the road with my family, looking out the window. Seeing these tanker trucks, the gasoline tanker trucks. I'll either see a sign that says "Flammable", which makes perfect sense to me, and then you have another one that says "inflammable" and they both mean the same. How did that happen?

Professor Pyne: That's pretty stupid, isn't it? Yes. I think what happened is that when we see inflammable, we think of "in" meaning "not", not flammable. That's not what it means. It means en, e-n, as in the sense, "to inflame", to involve in flame. Both terms, because of this history, are available.

I tell you personally, I avoid inflammable because of the confusion. Flammable is perfectly usable, and I always use that.

Dr. Biology: Well that helps answer that question.

Professor Pyne: Avoid the issue.

Dr. Biology: [laughs] I'm telling you, it's been a topic in our car many times. [Professor Pyne laughs] Before I sign off, you have a new book coming out, right?

Professor Pyne: I have a book called "Awful Splendor: The Fire History of Canada." That's a term that I use from a 19th century observer of a Canadian fire. I think the term we would use today is probably "awesome, " but it literally meant full of awe. It was sort of terrifying, yet spectacular, was the sense.

Dr. Biology: Well if you want to learn more about Dr. Pyne's writings, just go up onto Amazon, is my favorite place to go searching. I want you to look up a couple of these are kind of fun to read. One is, "The Burning Bush" right? Is one of the earliest ones. I like the sequel to it, "The Still Burning Bush" which I really like. You can just find him by typing S-T-E-P-H-E-N, and then P-Y-N-E, instead of P-I-N-E, it's P-Y-N-E. Now I find that a neat match, having the last name of Pyne and dealing with forest fires. In many ways I thought that was very unique.

Professor Pyne: The Pines are a fire adapted, and, in many cases, fire loving species. It's appropriate.

Dr. Biology: Well, I want to thank you, Professor Pyne, for spending some time with us. This has been very illuminating, I should say.

Professor Pyne: Well, thank you.

Dr. Biology: You've been listening to, "Ask a Biologist," and my guest has been Professor Stephen Pyne from the ASU school of Life Sciences. The "Ask a Biologist" podcast is produced on the campus of Arizona State University, and even though our program is not broadcast live, you can still send us your questions about biology using our companion website. The address is, askabiologist.asu.edu. Or, you can just google the words, Ask a Biologist. I'm Dr. Biology.